Recirculating systems

Recirculating systems re-use water. Intense filtering and aeration of the water allow aquaculturists to grow fish indoors. The process has some advantages like control of predators and easy removal of wastes.

For grow-out farms

Recirculation systems do have a place in the market today, but it's strictly limited. While a closed system makes sense for fingerling production, headstarting, or overwintering fish, such a system is not as cost-efficient for growing fish to full market size.

The long-term future of closed fish-growing systems is bright. Someday we will grow fish that way. But in today's economy, large-scale closed systems for fish grow-out make no sense in strictly business sense.

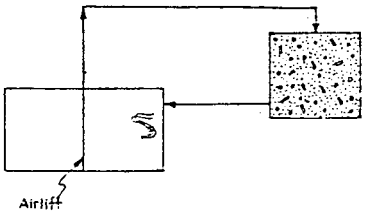
Reference: ***Seiche***. Winter 1994. University of Minnesota.

For tiger shrimp broodstock and hatchery

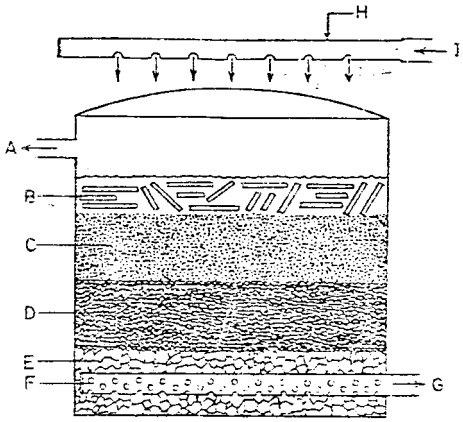
For tiger shrimp broodstock tanks, a recirculating system with preconditioned biological filter (like that described below for larval rearing) is effective in maintaining good water quality. The system can maintain ammonia levels below 1 ppm, pH in effluent water at 7.8-8.3, and biological oxygen demand (BOD_5) below 10 ppm. Dissolved oxygen, however, tend to drop due to the nitrifying activity of the filter. Reproductive performance of tiger shrimp seems to be better in this recirculating system than in a flow-through system.

Aeration systems (airstones and airlifts) and partial water change can not truly maintain good water quality in rearing tiger shrimp larvae. Instead, a system that also incorporates waste removal can do better. A choice can be made between biological filtration and zigzag stream sedimentation.

The biological filter designed and tested by SEAFDEC/AQD is constructed in a 100-liter tank and consists of coarse sand, gravel, and crushed rock:

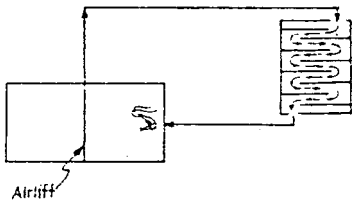


Biofilter volume: 100 liters
Wastewater flow rate: 1.6 liter-min

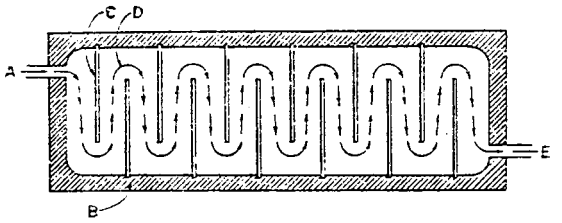


Cross section of the biological filter: A, overflow; B, PVC nodules; C, coarse sand; D, gravel; E, crushed rock; F, perforated pipe; G, outflow; H, head pipe for wastewater; I, inlet

The zigzag stream sedimentation tank measures 150 x 60 x 30 cm and is made of marine plywood and provided with six equally spaced wooden baffles that can deflect the water to zigzag in the stream.



Tank volume: 180 liters
Wastewater flow rate: 1.1 liter-min



Top view of zigzag sedimentation tank: A, inlet; B, marine plywood; C, baffles; D, zigzag flow; E, outlet.

The recirculating systems can maintain BOD_5 values lower than 10 mg/l, dissolved oxygen values higher than 5 mg/l at all times, and tolerable levels of ammonia and nitrite. BOD_5 greater than 10 mg/l can adversely affect growth. The accumulated sediments can be flushed out periodically.

Reference: OM Millamena, CM Casalmir, PF Subosa. 1991. *Performance of recirculating systems for prawn hatchery and broodstock maturation tanks.* **Aquaculture Engineering** 10: 161-171.

Books on fish health published by SEAFDEC/AQD

- **Diseases of Penaeid Shrimps in the Philippines.** 1992. By MCL Baticados et al. Aquaculture Extension Manual No. 16. 46 pp.
  The manual costs ₱100 in the Philippines or US$20 for foreign orders.

- **Recommended Practices for Disease Prevention in Prawn and Shrimp Hatcheries.** 1992. By G. Lio-Po et al. Aquaculture Extension Pamphlet No. 3. 14 pp.
  The pamphlet costs ₱15 in the Philippines or US$14 for foreign orders.

Managing a fish hatchery with oxygen injection

Carrying capacity is based on two assumptions: (1) it is limited by oxygen consumption and accumulation of metabolites; and (2) the amount of oxygen consumed and quantity of metabolites are proportional to the amount of food given. Carrying capacity can therefore be increased by improving water quality. Space then is not the factor that limits production in hatcheries. Managing a fish hatchery with oxygen injection can increase the space -- effective water volume -- by twice its usual amount.

Rainbow trout hatchery: an example

An oxygenation system that can supersaturate (about 100% O_2 saturation) a small portion of the water supply has been developed. The unit is fully automatic, including the control of low or high water level and low or high oxygen. It can automatically activate an auxiliary power system during power failures. The premise for such a system is that as high concentrations of oxygen are injected into the water, dissolved nitrogen, which can be lethal to fish, is stripped.

Growth of rainbow trout in raceways was compared in three levels of oxygen -- 5.15 ppm (natural spring water), 7.5 ppm (medium O_2), and 8.4 ppm (high O_2). After about 9 months, production parameters were as follows:

	Natural spring water	Medium O_2	High O_2
Mean daily length increase (cm/day)	0.38	0.58	0.58
Average weight per fish (kg)	10.0	24.0	23.5
Feed conversion	1.89	1.21	1.20
Fat index	2.9	2.95	3.00
Condition factor (K)	1.11	1.12	1.16